

**The Effects of Student Life Upon the
Eyesight**

Circulars of Information of the Bureau of
Education No. 6-1881

By A. W. Calhoun

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1881**



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OF THE

BUREAU OF EDUCATION.

No. 6-1881.

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HOUN, M. D., PROFESSOR OF DISEASES OF THE EYE, EAR, AND
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THE REPORT OF STEPHEN DILLIARD THE ELDER, BY A. W. GAY,
HON. M. D., PROFESSOR OF DISEASES OF THE EYE AND EAR,
TRUST IN THE ATLANTA MEDICAL COLLEGE.

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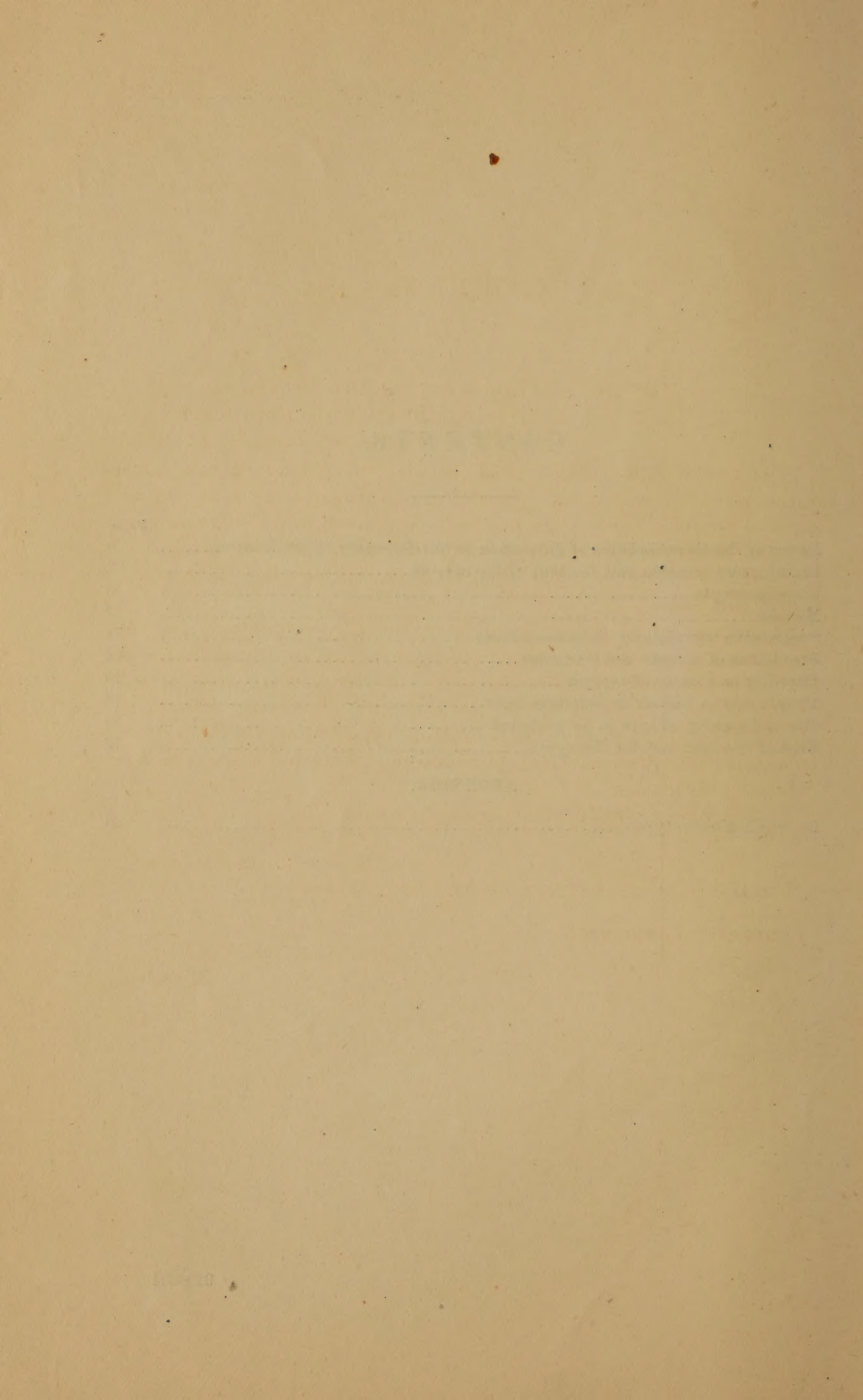
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LETTER.

DEPARTMENT OF THE INTERIOR,
BUREAU OF EDUCATION,
Washington, December 12, 1881.

SIR: In the first circular issued by this Office after I undertook its duties attention was called to the effects of school work upon the eyesight of pupils. The subject has been considered in the Office at different times since, as opportunity has offered. Public interest is especially aroused with reference to the importance of treating color blindness and shortsightedness.

At the meeting of the National Educational Association in July last, Dr. Calhoun, professor of diseases of the eye, ear, and throat in the Atlanta Medical College and an eminent oculist of that city, read a paper on the effects of student life on the eyesight. The paper was warmly approved by the distinguished educators present and its issue by this Office specially desired. I hereby recommend its publication as a circular of information.

Very respectfully, your obedient servant,

JOHN EATON,
Commissioner.

The Hon. the SECRETARY OF THE INTERIOR.

Publication approved.

S. J. KIRKWOOD,
Secretary.

EFFECTS OF STUDENT LIFE UPON THE EYESIGHT.

There have always been and even in our own day and time there still are those who are in doubt as to which is the most important of all our organs of sense. But especially often is the question asked, "Which is the greater deprivation, the loss of sight or the loss of hearing?" How almost universal is it that the blind appear bright, happy, and cheerfully resigned to the great loss they have sustained, while the deaf are not unfrequently dissatisfied, unhappy, and mistrustful. It has been my lot to have had much intercourse with these two classes, as well in private life as in the well filled and well managed institutions for their benefit throughout various portions of the world; and this remarkable contrast between them is the more apparent the more thorough and the more intimate my acquaintance becomes. The doubt, indeed, is untenable, for in the eye we have that organ which brings us into the most immediate relation and connection with the outer world, with mankind, with the brute creation, with all nature; for nature best expresses herself to us through her visibleness—eyesight alone enables us to comprehend. Nature offers much less for the hearing, for never can we learn to conceive of objects as they really are from the noises which may emanate from them and perceptibly strike our ear. On the contrary, imagination readily brings to mind the soft notes of the musical instruments that we see. We can often understand and comprehend men without hearing them, from the movements of the body and from their countenances: we can read from their lips what they speak when not a single tone is audible.

That sight is a direct aid and support to each of the other organs of sense can be readily tested and proven by each and every one. The finest and most delicate viands never taste so well as when we see them. The enjoyment of the most fragrant flower is considerably heightened by the sight of it. A sensation, however pleasant to the touch, is infinitely increased when we see the cause that calls it forth.

It is in the school room that the largest and most important portion of the child's life is spent, and while the whole energy is bent upon the proper development of the brain, it is not seldom that too little attention is given to the true maxim that "only in a healthy body can a healthy mind live." During these same years must the physical development progress; but how often can we trace back to those school days the groundwork of bodily ailments which prove to be stubborn barriers to all future advancement.

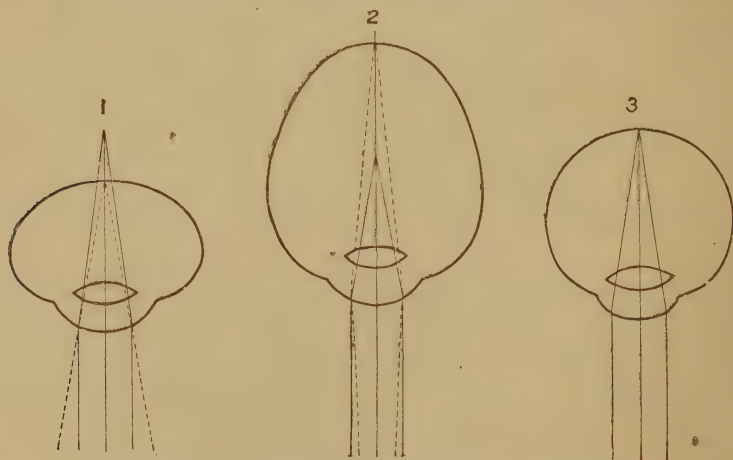
Now, as the eye must play the role of a mediator between the sub-

jects to be learned and the working brain, it is easy to understand that in the same proportion that work is demanded of the brain does a tax fall upon the eye; thus it happens also that the eye, which, like the general body, is perfecting itself during these very years of school life, undergoes not unfrequently powerful changes, which we can speak of only as diseased conditions, not only not admitting of cure, but here and there leading to the destruction of the organ of sight. After we have shown that the eye suffers such powerful and unwholesome changes during the years spent in the school room, then it is our purpose to demonstrate that certain influences during these years *originate* diseases of the eye, enumerating, in conclusion, the means with the help of which we hope to be able at least to limit the frequency and degree of intensity of these diseases.

DIVISION OF THE SUBJECT.

We always judge of an eye according to its length, and in eyes of different length we have different vision. In this particular we recognize three different conditions known as conditions of refraction. These are, first, hypermetropia, or oversightedness; second, myopia, or nearsightedness; third, emmetropia or normalsightedness.

That these conditions may be clearly understood, and for a thorough comprehension of the dangers dependent upon the second one, it is perhaps well that I should say a few words descriptive of them.



The hypermetropic or oversighted eye is too short a ball, and is a congenital defect.

The myopic or nearsighted eye is too long a ball, and in every degree from the slightest to the greatest is not only a real defect but also an absolute disease.

HYPERMETROPIA.

In the interior of every eye there is a circular muscle (the ciliary) known as the muscle of accommodation, by whose action we are enabled

to accommodate our vision to all distances, to near, distant, and all intermediate points. In the emmetropic or normalsighted eye, the action of this muscle produces no peculiar or unpleasant sensations, for it acts within its normal limits. But in the oversighted or hypermetropic eye, both for seeing distinctly in the distance and very specially for seeing near objects, this little muscle must exercise excessive force; and, indeed, the excess of force is the greater the more oversighted the eye or the shorter the ball. A muscle that is brought into constant unnatural activity gradually passes over into a convulsive, spasmodic condition or is so much fatigued that it is no longer able to undergo work. Both of these conditions take place in the human eye. The characteristic symptoms of this condition are as follows: Such persons (adults as well as children) are able to execute the very finest work, for a greater or less time, perhaps without trouble, then gradually, maybe suddenly, the work becomes indistinct, obscured, and things seem to run into one another. At times it appears as if a cloud were floating immediately in front of the eye, and one is no longer able to continue the work, and as a consequence a few moments' rest follows; the eyes are rubbed, and after a pause of a short interval the work is again resumed, but mostly only for a short time, for the same symptoms return. Particularly is this the case towards evening, after an entire day's toil, or towards the end of the week, after a whole week's constant use of the eyes, while on Monday, and especially Monday morning, in consequence of resting the eye, and therefore resting the muscle of accommodation on the inside of the eye, during Sunday, the vision is at its very best. In some instances this wearied condition of the muscle appears so suddenly that the persons affected think themselves blinded, and when they seek assistance and are told that the use of proper glasses will forever remove the trouble, they are astonished as well as rejoiced. Unfortunately, it is not seldom the case that a great wrong is done children affected with oversightedness, parents and teachers attributing the difficulty with which they advance in their studies to a "stubborn will" or "idleness," manifesting itself in their complaints of tired eyes, inability to go on with study, headaches, and so on, when in truth it is due to the overtaxed muscle of accommodation. I have had frequent occasion to call these facts to the attention of parents and teachers whose children or pupils may have been sufferers from oversightedness.

MYOPIA.

But it is to that condition of refraction known as myopia or nearsightedness that I wish to direct attention specially, for while the oversighted eye is an eye of defective growth without disease, the nearsighted ball is not only defective in growth, for it is too long, but is in the real sense of the term a diseased eye. The celebrated Donders, in his work on refraction, takes this as his motto: "I speak it without hesitation, that a nearsighted eye is a diseased eye." Let every one, then,

seek diligently not to become nearsighted. As we have seen, the longer the eye the greater the nearsightedness, and the highest degree of this corresponds to the longest eye. Very rarely before the fifth or sixth year of life does nearsightedness make its appearance, about which time children usually begin their attendance upon school; but from this time on, under certain unfavorable circumstances, the eye gradually elongates, reaching and remaining perhaps at a certain point of elongation, a slight or high degree, or constantly increasing through all the years of school life, even to the twentieth or twenty-fifth year, and indeed in some instances continuing slowly to lengthen through almost the whole of life.

CONSEQUENCES OF MYOPIA.

But it is not simply the elongation of the ball that is so much to be feared, but consequent changes which have an important bearing on the acuteness of vision, on the movements and on the very existence of the eye. If one hundred men with perfectly good eyes are able to recognize or read at a certain distance, say twenty feet, one and the same letter or number of letters, it is reasonable to conclude that any other person with equally good eyes can recognize and read the same letter or letters at the same distance. But if one is incapable of doing this, even with the defect of refraction (if such exists) corrected by proper glasses, then this one has less acuteness of vision than the one hundred who are able to do so. This diminution of vision is a frequent and common circumstance with nearsighted individuals, and depends upon the diseased changes taking place on the interior of the eye brought about by the abnormal lengthening of the ball. The movements of the ball are controlled by six muscles, and over their action nearsightedness exercises a very great influence, because of the ball being so long. There exists a peculiar but certain connection between nearsightedness and the contraction of one of these muscles (the outer), causing the eye to turn outwards and constituting what in common parlance is known as external squint or cross eyes. A corresponding connection exists also between oversightedness and internal squint, so that, indeed, in the majority of instances we are able to say when we see a person squinting outwards that he is nearsighted, and when inwards that he is oversighted. There are, of course, exceptions to this rule. In every nearsighted individual the very existence of the eye is in danger, but especially so in those cases of progressive myopia attaining finally a high degree. Such an eye may any moment become suddenly blinded through detachment of the retina, the lining nervous membrane of the interior of the eye, resulting always in a very material reduction of sight, and in the majority of cases in irretrievable loss of vision.¹

¹ Predisposition to myopia is almost always inherited by at least some of the children where one parent is myopic. In these children myopia may often be detected, if sought for, at a very early age, and is generally evident at from eight to twelve years

Doubtless the question has already been asked, Cannot this too short eye be made longer and this too long eye be made shorter? No, I answer, for these changes in the eye must remain forever unchanged; but we can correct the defect in the oversighted eye, in so far as the unpleasant and painful symptoms from the use of such an eye are concerned, and make the vision as comfortable as in the normalsighted person. And we can make the nearsighted see not only near but distant objects. It would be out of place here to go into a detailed description of the means at our command for such correction. Suffice it to say, it is done in the first instance (the oversighted eye) by the use of convex, in the second (the nearsighted eye) by the use of concave glasses.

The question naturally propounds itself, Are we able to prevent this diseased lengthening of the eyeball, this nearsightedness, or after it has begun are we in condition at least to prevent its increase? This is a question full of the most vital importance, and it is the question that has led to the investigation of the eyes of a very large number of school

of age. Once present, it tends to increase, and should be watched with care. If not existing at least in some slight degree before sixteen years of age it is never developed, even by excessive use of the eyes; nor does it appear unless exceptionally in eyes originally hyperopic.

Three conditions of myopia are to be recognized: stationary myopia, where having reached a certain degree no other change occurs; temporarily progressive myopia, where there is for a time increase of optical and structural changes; and constantly progressive myopia, where the morbid processes go on to more or less destructive terminations.

During the period of youth, which is usually also the time of closest application to study, there is a disposition to gradual development of the inherited myopic tendency; but this may be kept in abeyance if the eyes are used principally for large objects; and if, during this period, the myopia does not become very considerable, it may remain stationary during the rest of life. Temporary increase of myopia may take place during these years of growth and of study from too close application; but, provided its degree is still moderate, its further progress may be arrested at or after maturity if the individual grows more prudent. But—and this constitutes the greatest feature of the disease—if the myopia has, during this period, already reached a high degree, the tendency to continued progress frequently cannot be arrested, notwithstanding the exercise, too late, of the greatest care; and degenerative changes go on in the tissues and media of the eye, with the sad prospect of partial or even total blindness at or before middle age.

The earlier symptoms of progressive myopia are often a mere increase in the imperfection of distant vision, without other apparent inconvenience than the need of stronger glasses. Afterward, as the changed form of the eyeball makes accommodation for near objects less easy, the eyes are readily fatigued and irritable, perhaps hyperæmic, and sensitive to light; * * * *muscæ volitantes* [or perpetually moving black spots] are often complained of. * * * The downward course of progressive myopia is accompanied by * * * much general deterioration of the acuteness of sight, * * * perhaps followed by * * * absolute loss of vision at the very period when family cares or public duties are most imperative.

Since it has been shown that it is especially by continued tension of the muscle of accommodation in study that myopia with its attendant dangers is generated and increased, and as it is well known to be only preventable and not curable, it follows

children, after it had once become positively known that nearsightedness developed itself particularly, indeed almost exclusively, and attained its very highest degree, during the years of school life.

PREVALENCE OF MYOPIA AND ITS CAUSES.

So far as I can gather, there are records of the examinations of the eyes of about 45,000 school children, of all ages and of all grades, representing both white and colored races and both country and city schools. Some of these investigations would lead us to conclude that the percentage of normalsighted children, other researches that the percentage of oversighted, prevailed in the largest degree, but all, without a single

that a change in our methods of education is an absolute necessity, or else this, which might be termed self-imposed disease, will impose a more and more grievous burden on the community.

A child having an hereditary leaning toward myopia is expected to give a large portion of time every day to study of oftentimes badly printed books, perhaps in a dim light, and sometimes with the requirement from his teacher that he shall not take his eyes from his lesson. Myopia is thus begun. As this augments, the child who does not see things about him clearly has less pleasure in the usual sports of his age, and finds more enjoyment in books. His close application to reading, writing, drawing, &c., keeps up convergence of the eyes and pressure upon them of the recti muscles, which tends little by little to increase the ellipsoid change of form and elongate the antero-posterior axis. These alterations go on during the period of growth and of most continuous study, because at this time the tissues of the globe are softer and more extensible than after maturity. If on reaching this latter term the structural changes are still only moderate in degree, the myopia may continue stationary during life. But if at this time great deviations from the normal condition have already been produced, the affected parts are less capable of resisting further yielding, and progressive myopia is thenceforward an ever-present source of danger.

As is evident from the description of the nature of the pathological changes, prevention is the sole resource at our command; restoration is impossible. And in order that preventive measures may be seasonably adopted, it is first necessary that the profession and the public should become alive to the fact that in a large number of cases myopia is one of the gravest affections of the eye, capable of limitation by constant care during childhood and youth; but if not thus limited likely to be a source of future disability and misery, and to be handed down as an onerous inheritance to children. At present the warnings inspired by frequent sad experience in the practice of every skilled observer are almost unheeded, and it is but too common to see the chances of retaining even moderately useful vision in future years recklessly sacrificed to a vain ambition for acquiring mere book knowledge, which when gained is often valueless to its possessor, or, if otherwise it could be usefully applied, cannot be made serviceable because of the imperfection of sight which has been created in obtaining it.

Very high degrees of myopia should also be recognized as an infirmity deserving careful consideration before assuming the obligations of marriage; for those in moderate circumstances may well hesitate to choose partners who, though highly cultivated, may probably at middle life become unable to provide for their households or their children.

It should be understood that if these risks of future disability are to be avoided it is imperative that when they are shown to be unmistakably present such pursuits as increase them must be at once abandoned, in whole or in part, at whatever sacrifice of preference or ambition. Parents should modify plans for their children's training and choice of pursuit, so as not to imperil their eyes. Older persons who have already

exception, prove beyond a doubt that nearsightedness, beginning, perhaps, at nothing in the lowest classes and first years of school life, steadily increases from class to class in the school, until in the highest grades or in the last years of school attendance it has actually developed itself in as many as 60 or 70 per cent. of all the pupils. Among this large number we have children whose ages range all along from five to twenty years and upwards, all similarly occupied, and during a time in which the eye undergoes its most important changes—changes which will influence more or less the regulation of the children's entire lives. In the school room we can follow the eye from its beginning on, from its primitive condition, as it were, where as yet it has been exposed to no injuri-

developed a high degree of myopia, but who feel obliged to continue their preparations for some vocation for which they are especially fitted, or in which they see opportunities, should keep in mind the risks to which they are exposed, and should avoid too intense or continuous application and efforts to obtain class rank or other temporary distinctions, and if necessary should take more time than would otherwise be required for a certain amount of work. If they expect to depend for their support upon occupations which will not only tax the eyes in preparation but in their pursuit, it is of the utmost importance to preserve these eyes in the best condition possible, and not sacrifice future prospects from disability to accomplish what they had qualified themselves to do. Those who do not study as a means of obtaining a livelihood, but merely for the pleasure of literary acquisition, should feel it a duty incumbent on them to refrain from the continuous excessive use of the eyes to which their tastes so strongly tempt them; not only that they may prevent progressive and dangerous changes in their own eyes, but also to avoid developing a condition which will often become a baleful possession for their children.

Vision has been carefully tested in many thousands of eyes of school children in Austria, Germany, Russia, Switzerland, and America, with everywhere similar results. The statistics thus gathered show that while in children at common village schools there is but 1.4 per cent. of myopia, the proportion rises to 21 per cent. in city schools of high grade, and to 40 per cent. in some universities. They show also that not only the numerical ratio but the degree of myopia is far greater in the higher than in the lower classes of the same schools—those children who had no myopia, or only a moderate amount of it, acquiring or largely increasing it in their progress through the advanced classes. Other statistics have shown that in those who studied two hours out of school the proportion of nearsighted was 17 per cent.; in those studying six hours, 40 per cent. In America, probably on account of the greater activity and variety of life and the less degree as yet of hereditary tendency, the ratio has been found to be smaller than in Europe.

These facts deserve serious attention, especially in connection with our undoubted power of modifying or arresting the progress of myopia by proper management and by self-denial during the years of growth and of education. We have seen that if myopia does not begin before the age of sixteen it is not afterwards developed. We know also that if at the age of twenty, when the system has become matured, the myopia remains only moderate in degree, not more than $\frac{1}{10}$, it may remain at this point during life, unless imprudent use of the eyes is indulged in, without exhibiting progressive features. This degree of $\frac{1}{10}$ is deemed by good authorities the line of safety. If at twenty years of age the myopia is less than this, there is little danger, with reasonable care, that further changes will declare themselves; if more than this degree exists, constant watchfulness is needed to prevent further deterioration.—(The Diagnosis and Treatment of the Diseases of the Eye, by Dr. Henry W. Williams, Boston, 1881.)

ous influences, and can follow it through a series of years to an age in which we can mark the boundary beyond which we can say the further development of it under certain conditions will be for good, and under other conditions for evil.

Now, we have found that in the very early years of life no eye is nearsighted, and even in the lowest classes at school no nearsightedness exists, or, if at all, only in the slightest degree, and also that in the highest and last school classes, containing the oldest pupils, as much as 70 or even a larger per cent. of the scholars are nearsighted. Knowing all this, the question presses itself upon us, How is it possible for an eye in a space of time from twelve to fifteen years to undergo such a transformation? If nature prescribes or dictates these changes in the human eye, why is it, then, that all are not nearsighted? Or do unfavorable circumstances or conditions lend their assistance in bringing about this diseased lengthening of the eyeball? Or have the sufferers inherited the disease from their parents or ancestors; and, if so, why is it that these children are not nearsighted from birth?

Some very interesting observations have been made during these investigations, and prominent among them are:

(1) That oversightedness (a too short ball) is originally the normal condition of the eye, and to reach the nearsighted state (a too long ball) the eye must pass through the normalsighted condition (a normal sized ball).

(2) That with the increase in years and with the rise in classes the number of nearsighted children more or less rapidly increases.

(3) That nearsightedness is much more frequent in city schools than in schools in the rural districts, due to the better surroundings in the country, less strain and more rest for the eye.

(4) That colored school children are remarkably free from nearsightedness, the percentage being exceedingly small. In my own examinations of this class of students, I have seen very few who were nearsighted.

(5) That children frequently have the trouble whose parents or grandparents had the same, and that the acuity of vision is more frequently defective among the nearsighted than among any others.

I have before me the results of the examinations of the eyes of nearly 2,200 school children in and around Bern, the capital of Switzerland, and I take these tables because they are a fair type of all the others. These show that a majority of the children begin school life with emmetropic or normal conditioned eyes, but that the number of normalsighted children invariably and constantly diminishes as they rise from grade to grade. They show, also, on the other hand, that myopic or nearsighted eyes scarcely exist at all, or in very small numbers, in the youngest children or in the lowest classes, but as the children grow older and go higher and higher in studies requiring closer application of their eyes, just as invariably and just as constantly does nearsightedness increase, normalsightedness diminishing under the opposite condition of

things. In similar proportion, also, as nearsightedness increases does oversightedness diminish. This shows beyond the shadow of a doubt that both normalsighted and oversighted eyes (with one of which almost all children are born), under the influence of school life and other unhealthy surroundings, gradually lose their healthy condition, until finally in the last school years and in the highest grades or classes nearsightedness, a truly diseased condition of the eye, becomes the condition of refraction in as many as 70 per cent. of those now just in the very beginning of manhood or womanhood.

This is truly a sad picture and a sad commentary upon the boasted civilization of the latter half of the nineteenth century, but it is true to the very letter, and needs but a most superficial study of the subject to convince him who doubts most.

But not only among school children do we find nearsightedness developing itself, but also among teachers, book-keepers, engravers, watch-makers, newspaper men, and indeed among all those who have occasion to look at small objects for a long time, keeping the muscle of accommodation in a continued strain for a greater or less period. In all adults, however, the disease develops itself with much less frequency and with more difficulty than in children, because the tissues forming the eyeballs in the grown person have received their growth, become hardened, and are much less influenced by excessive use than those of a child. Is it, then, a great misfortune to become nearsighted? Since a nearsighted eye is a diseased eye, this question bears its own answer upon its face. But what is the cause of nearsightedness; and since we cannot cure the disease, cannot make this too long ball short again, are we not able to prevent others from falling into the same unfortunate condition? The two principal causes are heredity and occupation. Others may exist, but they are unimportant in comparison with these two. That oversightedness is often hereditary is a matter of everyday observation, several members of the same family not only having the defect but oftentimes having it exactly in the same degree that existed in the eyes of their parents or grandparents. Of necessity must hypermetropia or oversightedness be at least congenital, but not so with myopia or nearsightedness, for it can either be hereditary or acquired. The tendency to the trouble may exist from birth, but the disease itself may never crop out unless conditions favorable to it present themselves. On the contrary, also, very many children acquire nearsightedness in whom there is no natural tendency to the disease, whose parents or grandparents were entirely free from it.

HEREDITY AS A CAUSE OF MYOPIA.

It has been mentioned that in the children in country schools nearsightedness is, comparatively speaking, scarcely to be found. These pupils are the children of parents who themselves, perhaps, attended school but little during the early years of their lives and have strained

their eyes very little on near objects; hence the absence of an hereditary tendency to the disease in their children. The parents and grandparents of city school children have themselves, perhaps for generations back, attended city schools, and have year after year engaged in those avocations in the city which are a constant strain to the muscles (particularly the ciliary) of the eye, leading ultimately to a lengthening of the ball, a tendency to which is transmitted from generation to generation. Out of nearly five hundred negro school children examined in New York by Dr. Callan, only $2\frac{1}{2}$ per cent. were found to be nearsighted, and out of thousands of the natives of British India examined by British surgeons not a single one was found to be nearsighted. Among a large number of negroes examined by myself from time to time, not more than half a dozen cases of nearsightedness have as yet been revealed. These were in grown negro men, who for eight or ten years had applied themselves unremittingly to their studies and had acquired a very extraordinary amount of intelligence, but at the cost of a defect of their eyes which must forever leave them in a diseased state. The negroes, then, are as yet but little subject to nearsightedness; because their forefathers never had occasion to use their eyes to an injurious extent they have inherited from them only the tendency to good eyesight.

MYOPIA DUE TO BAD AIR OR DEFECTIVE LIGHT.

Now, while heredity gives rise to the tendency to nearsightedness and certain subsequent avocations cause its full development in a large number of instances, still there is no doubt whatever that the avocations of individuals during school years, as well as later, are often the sole cause of the disease, without the existence of the slightest hereditary tendency. In the school room there are two kinds of influence that work injuriously upon the eyesight. Under the first are classed all those things which compel the eye to strain itself in order to see distinctly small letters or objects; under the second, all those which cause a congestion or rush of blood to the head and eyes. To the first belong bad ventilation and improper light, too small and imperfect type, pale ink, many successive hours at the same kind of work, as in reading, writing, sewing, &c., without change or rest of the eye, all sorts of toil causing the use of the eye until late at night and sometimes with very defective light. To the second belong not only those things just enumerated, but also the construction and arrangement of school desks and benches, which, in many schools, make it next to impossible for pupils to hold their bodies in proper position for any length of time.

In order to demonstrate the role that bad air, bad light, &c., play in the school room, I extract some pertinent remarks from a paper published by Dr. Loring, of New York. He says: "I am, therefore, of the opinion that bad air alone, acting as the primal cause, may set in train a series of morbid processes which may, and often do, affect not only the working capacity and integrity of the organ, but which may lead even to its

total destruction. Thus simple irritation of the mucous membrane of the eye may, and often does, pass into actual inflammation, which, increasing in violence, may proceed from part to part till the entire organ is involved, and thus the sight become impaired or totally lost.

"Ought not the light to fall, not full in the face of the child, but first on the book or work and be reflected into the eye? Before answering this question precisely as it now stands, I should like to premise it by making the general assertion that not only is the direction in which the light comes important, but also its quantity and quality. Reduction in illumination is as a rule precisely equivalent to a reduction in the size of the object; therefore, the less the light the nearer an object must be brought to the eye, and the greater the strain in the act of vision. It is impossible to fix with any scientific exactness just the size that a window should be to give sufficient light for visual purposes, since this must vary with the exposure and surroundings of the room; but it has been reckoned in Germany that for a class room containing twenty persons there should be at least four to six thousand square inches of glass, which would give to each scholar from 200 to 300 square inches, or what would be represented by a pane of glass from 14 to 17 inches square. Such a room as this would be sufficiently lighted in any part. A room 20 feet square should not contain less than 70 to 80 square feet of glass, and it may be laid down as a rule that too much light cannot be obtained in a room, as all excess of glare can be guarded against by artificial shades if properly applied. More light enters the room from the same amount of glass from the south than from the north, and a southern, southeastern, or southwestern exposure is better than a northern, northeastern, or northwestern, especially for class rooms, and this, too, simply in regard to the amount of light and independent of the purifying influences of direct sunlight. That a north room is better for the purposes of the artist is due to other causes and does not affect the general rule. [But see the opinion of Dr. Jones, quoted on p. 18, note.]

"The light should not come from directly in front, and especially is this the rule when artificial light is used. For when the light comes from directly in front of the person, the pupil of the eye becomes unduly contracted, which is equivalent to reducing the quantity of light, since less light enters the eye from the object viewed, while the eye is exposed to too much light reflected from the surrounding objects, and from the direct rays from the source of illumination. Neither should the light come from directly behind, as the object then lies in the shadow of the body. Nor yet from the right side, because in writing the shadow of the hand falls across the page, and a moving shadow over a lighted surface not only reduces the quantity of light and leads to a stooping position, but it is also more annoying to the eye than a uniform reduction in the illumination of even a greater degree." The best direction for the light to come from is the left hand side, and

from rather above than below the level of the head. Windows, therefore, should not be run down too near to the floor, as they often are in class rooms and offices. I do not agree with the opinion often expressed, that the best light is that coming from directly above. I cannot refrain from adding, in this connection, the conclusion founded on Dr. Cohn's elaborate investigations in regard to nearsightedness among school children in Germany. He thus formulates it: "The narrower the street in which the school-house was built, the higher the opposite buildings, and the lower the story occupied by the class, the greater the number of nearsighted scholars." I should, then, from these considerations, say that the angle at which the light strikes the eye is important.¹

SIZE AND QUALITY OF TYPE TO BE PREFERRED.

Do the size and quality of the type cause disease of the eye? Young children should never hold the book nearer to the eye than ten inches and adults never farther from the eye than eighteen inches. As soon as perfectly distinct vision at this distance cannot be obtained, and if obtained cannot be easily maintained, recourse should be had to spectacles. The finer, then, the type the closer the book has to be brought to the eye, and the greater the tension or demand on the focalizing power and the muscles which are used in bringing both eyes to bear at the same time upon the object viewed. These two acts make what is called the act of accommodation of the eye, and tension of the accommodation, that is, long continued use of the eye upon objects brought close to it, is considered by all authorities one of the most (if not the most) fertile causes of progressive nearsightedness. This condition may be accompanied by morbid processes which may involve the deeper seated membranes of the eye to such a degree as not only to affect the vision but to destroy it. Too fine print, therefore, may be, I think, looked upon as a factor in producing eye disease, affecting not only the external but also the internal parts of the organ. On the other hand, too coarse print is wearisome to the eye, as it requires more exertion of the muscles governing the movements of the eye, that is, for a given amount of matter, and especially is this the case when the breadth of the page is, if anything, too great. This causes undue exertion on the part of the muscles which move the eye in a lateral direction and is apt to lead to confusion in finding the next succeeding line. It is for this reason that the narrow form of English blank verse is so little fatiguing to the eye. A double column page which is well printed and properly divided is cer-

¹ "The window by which we read, write, draw, sew, or do any other such work should look towards the north rather than towards other directions. And the desk or work-table should be so placed that the light from the window may fall obliquely from above, behind, and over the left shoulder, on the book, paper, or work. By this arrangement the light does not fall directly into our eyes, nor is it reflected directly back from the object into them."—(Defects of Sight and Hearing, by Dr. T. Wharton Jones.)

tainly preferable to the same amount of matter extending in a single line across the entire page.¹

The less contrast there is between an object and its surroundings, the more difficult it is to see the object and the closer it has to be brought to the eye. A faintly printed page has, therefore, to be brought nearer, oftentimes very much nearer, than a well printed page of the same type. There is nothing more wearisome to an eye than an indistinct and blurred image of a familiar object, and no more striking example of this could be found than blurred or faintly printed type. This should be sharply cut, and be what is technically called "heavy faced," in contradistinction to "light faced" type. Of the former a common example is the English; of the latter, the American. The ink is also a matter of importance. English ink, like the type, is vastly superior to ours. The color and quality of the paper have also an influence upon the ease with which the act of vision is performed; for, while it is true that there should be as much contrast as possible between the type and its surroundings, care should be taken to avoid all glare or dazzling of the page. Pure white paper, such as is ordinarily used in this country, should not be employed, most of all when it has, as it often has in the cheaper papers, a metallic lustre with a bluish tinge. I have come to the conclusion that, as a rule, a very light, almost imperceptible, yellow tinge is the best. This is known to the trade as "natural" tint, from the fact that it contains no dye whatever and has been bleached only to a moderate degree. It has the color of unbleached cotton cloth. It is, however expensive, as it can be made only from the best stock; still, a very good imitation can be had in some of the second class papers at a moderate cost. The paper should be thick enough not to be transparent, and should have a close, fine texture and be free from sponginess. From these facts, I am of the opinion that, both in respect to size and quality, imperfect type may be considered as a factor in the production of eye diseases.

NEED OF REST AND CARE FOR THE EYES.

Does too long and constrained attention to one object, without rest or variety, cause eye disease? That prolonged tension of the eyes may be the primal cause of a great number of diseases of the eye is admitted by all authorities, and the more fixed the gaze and the narrower the field

¹ The individual experience of each reader will be his most trustworthy guide as to the suitability of different sizes of print for his own use; any suggestions on this point, therefore, beyond the caution to heed the first intimations received that the strain to which the eyes are being subjected is too great, seem uncalled for. In order that the reader, however, may be able to determine whether he enjoys normal vision there has been added in the appendix a set of Snellen's test types, with the respective distances in feet at which each should be distinctly legible. Various schemes for determining visual power have been devised, but the test types of Professor Snellen, of Utrecht, here given, have long been in the most general use. At the London International Medical Congress of 1881 they were named as the proper tests for mariners and railway employés.— (Note by the Commissioner.)

of view the greater the danger. If it be true that continued tension of muscular and nervous force unduly exhausts the energy of any organ, it is doubly true of the eye. The nervous energy of the retina, sensitive and rapid as it is, is just as rapidly exhausted, and the act of reading would be unbearable after a few moments if the eye did not quickly change its position from letter to letter and from line to line. Diversity of action is as much a necessity in the case of the eye as of any other organ for an easy and lasting performance of its functions. No eye, in my opinion, should be used more than an hour at the furthest in the act of reading or writing without an interruption of the gaze, and it would be better if several, if not many, interruptions should take place in the same time. This usually happens in the case of adults, for some reason or other; but children, in order to complete their tasks in an allotted time, are often compelled to use their eyes, without sufficient interruption, by the hour together. It would be impossible, and out of keeping with the condensed character of these remarks, to enumerate here all the diseases which may arise from prolonged tension of the eyes on near work; but there is one affection produced by it which is so frequent in its occurrence and so unfortunate in its results that I cannot refrain from quoting the remarks of the distinguished Professor Donders. He says:

"The distribution of nearsightedness chiefly in the cultivated ranks points directly to its principal cause, viz, tension of the eyes for near objects. Respecting this fact there can be no doubt. Three factors may here come under observation: (1) Pressure of the muscles on the eyeball in strong convergence of the visual axes; (2) increased pressure of the fluids, resulting from accumulation of blood in the eye in stooping; (3) congestive processes in the eye, which, tending to softening, give rise to extension of the membranes. Now, in connection with the causes mentioned, the injurious effect of fine work is, by imperfect illumination, still more increased. To this it is to be ascribed that in schools where, by bad light, the pupils read bad print or write with pale ink, the foundation of nearsightedness is mainly laid, which, in fact, is usually developed in these years."

But little will be said in reference to desks and seats, though it would seem they deserve the most careful consideration on the part of those in charge of the education of children, since a large portion of a child's life is spent behind the one and upon the other. It has been contended that every pupil should have a desk to suit his size, but that in many instances is impracticable for several reasons, but mainly on account of the expense. The chief idea to be borne in mind in the arrangement of desks is that they should be so constructed that the children can sit without becoming too rapidly wearied and that the desks should not be so low as to cause the body to bend forward nor so high as to make studying difficult, as in writing, for instance. But of what use are all these proper arrangements at school, if, as soon as the children get to their own homes, they write and study at tables that are inconvenient even for the grown

members of the family? Of what benefit is the most superb illumination in the school room if the children, when at home, work several hours of the day in the corner of a badly-lighted chamber, and at night by the light of a flickering candle or lamp, used perhaps by five or six others of the family, and which is insufficient to properly light up the book or map of even one or two of these children? If we wish to protect the eyes of children during the time in which they are acquiring their education, give them, above all things else, plenty of well regulated light. They should be prohibited from using their books during twilight, by the light of the moon, and certainly should they be forbidden such dangerous use of their eyes as reading in bed. Says a well known writer: "It seems to me that the very etymology of the word education enforces the idea that the child is to grow better and stronger up through his school life; that by proper regulation of his diet and management at home, by properly lighted school-rooms and properly constructed desks, and by a better regulation of his hours of study, he should represent a much higher type of life when he has reached the age of twenty-five than when he is just taken in hand with the view of giving him book knowledge. We certainly should not damage the eye in the process of education, and I believe that the damage done to the eye is to be taken as an index of that which is done to the other organs of the body." In conclusion, when every school-house in the land and every school room and every school desk shall have been properly constructed according to the most scientific investigations, and plenty of good light thrown upon books properly and plainly printed with good ink; when the habits of study of all children shall have been regulated, both in the school room and at home, then do I feel convinced that, while we may not be able to banish these particular eye diseases from the world, without doubt will we be able to reduce them in number and in severity.



APPENDIX.

DR. SNELLEN'S TEST TYPES.

In order that readers may ascertain whether they have normal vision, a list of Professor Snellen's test types is subjoined. The figures over the letters indicate the number of feet at which the letters should be distinctly legible. Variations from normal vision may be recorded by using the numerals given as denominators and the distance in feet at which the letters are clearly seen as numerators; thus, if letters which should be legible at twenty feet can only be clearly perceived at ten feet, vision = $\frac{10}{20}$.

1 ft. 8½ in.

OSLAGHOTEU

2 ft. 6 in.

ULHOEDTSFG

3 ft. 3½ in.

FOECHSUTDL

4 ft. 6 in.

ECLSTUFDCH

6 ft. 1½ in.

SLFDCEUHTO

7 ft.

DFSEOLUHCT

9 ft.

TCHDFSEULO

10 ft. $1\frac{1}{2}$ in.

E C H D L U T O F S

14 ft.

F O L U E D S T C H

15 ft. $2\frac{1}{2}$ in.

L S E O F D T H U C

21 ft.
U F D T C L S E O H

32 ft. 1 in.
C H O F D T

42 ft. 8½ in.
D F S E U

52 ft. 5 in.



73 ft.

